

**What is Claimed is:**

1. A chemical sensor that senses a chemical, comprising:  
a flexible substrate;  
a flexible lower electrode on the flexible substrate;  
a patterned flexible dielectric layer on the flexible lower electrode opposite the  
5 flexible substrate; and  
a patterned flexible upper electrode on the patterned flexible dielectric layer  
opposite the flexible lower electrode, the patterned flexible dielectric layer and the  
patterned flexible upper electrode being patterned to establish a current flow path  
between the flexible lower electrode and the patterned flexible upper electrode  
10 through the chemical, if present, upon application of voltage between the flexible  
lower electrode and the patterned flexible upper electrode.
2. A chemical sensor according to Claim 1 wherein the patterned flexible  
upper electrode includes a plurality of spaced apart fingers that are spaced apart from  
15 one another by at least an order of magnitude more than the thickness of the patterned  
flexible dielectric layer.
3. A chemical sensor according to Claim 1 wherein the patterned flexible  
dielectric layer is between about one quarter micron and about two microns thick and  
20 wherein adjacent fingers in the plurality of spaced apart fingers are spaced apart from  
one another by about five microns to about fifty microns.
4. A chemical sensor according to Claim 1 wherein the flexible lower  
electrode is an unpatterned flexible lower electrode.
- 25 5. A chemical sensor according to Claim 1 wherein the flexible substrate  
comprises polyimide.
6. A chemical sensor according to Claim 1 wherein the flexible dielectric  
30 layer comprises polyimide, a Plasma Enhanced Chemical Vapor Deposition (PECVD)  
coating and/or a Diamond-Like Carbon (DLC) coating.

7. A chemical sensor according to Claim 1 wherein the flexible lower electrode and the patterned flexible upper electrode each comprises gold, platinum, palladium and/or copper.

5 8. A chemical sensor according to Claim 1 wherein the substrate includes a substrate face, wherein the flexible lower electrode is on the substrate face and wherein the current flow path extends at least partially along a direction that is nonparallel to the substrate face.

10 9. A chemical sensor according to Claim 1 wherein the substrate includes a substrate face, wherein the flexible lower electrode is on the substrate face and wherein the current flow path extends at least partially along a direction that is orthogonal to the substrate face.

15 10. A chemical sensor according to Claim 1 wherein the flexible lower electrode is a patterned flexible lower electrode.

20 11. A chemical sensor according to Claim 10 wherein the patterned flexible lower electrode is patterned to establish a second current flow path between portions of the patterned flexible lower electrode through the chemical, if present, upon application of voltage between the portions of the patterned flexible lower electrode.

25 12. A chemical sensor according to Claim 11 wherein the patterned flexible upper electrode is patterned to establish a third current flow path between portions of the patterned flexible upper electrode through the chemical, if present, upon application of voltage between the portions of the patterned flexible upper electrode.

30 13. A chemical sensor according to Claim 1 wherein the patterned flexible upper electrode is patterned to establish a second current flow path between portions of the patterned flexible upper electrode through the chemical, if present, upon application of voltage between the portions of the patterned flexible upper electrode.

14. A chemical sensor according to Claim 10 wherein the patterned flexible upper electrode and the patterned flexible lower electrode both include a plurality of spaced apart fingers, the patterned flexible dielectric layer, the patterned flexible lower electrode and the patterned flexible upper electrode being patterned to establish a first current flow path between the patterned flexible lower electrode and the patterned flexible upper electrode through the chemical, if present, a second current flow path between adjacent fingers of the patterned flexible lower electrode through the chemical, if present, and a third current flow path between adjacent fingers of the patterned flexible upper electrode through the chemical, if present, upon application of voltage between the adjacent fingers of the patterned flexible lower electrode, between the adjacent fingers of the patterned flexible upper electrode and between adjacent fingers of the patterned upper and lower flexible electrodes.

15. A chemical sensor according to Claim 10 wherein the patterned flexible dielectric layer, the patterned flexible lower electrode and the patterned flexible upper electrode are patterned to establish a first current flow path between the patterned flexible lower electrode and the patterned flexible upper electrode through the chemical, if present, a second current flow path between portions of the patterned flexible lower electrode through the chemical, if present, and a third current flow path between portions of the patterned flexible upper electrode through the chemical, if present, upon application of voltage between the patterned flexible upper electrode and the patterned flexible lower electrode.

16. A chemical sensor that senses a chemical, comprising:  
a substrate;  
a lower electrode on the substrate;  
a patterned dielectric layer on the lower electrode opposite the substrate; and  
a patterned upper electrode on the patterned dielectric layer opposite the lower electrode, the patterned dielectric layer and the patterned upper electrode being patterned to establish a first current flow path between the lower electrode and the patterned upper electrode through the chemical, if present, upon application of voltage between the lower electrode and the patterned upper electrode and to establish a second current flow path between portions of the patterned upper electrode through

the chemical, if present, upon application of voltage between the portions of the patterned upper electrode.

17. A chemical sensor according to Claim 16 wherein the lower electrode  
5 is an unpatterned lower electrode.

18. A chemical sensor according to Claim 16 wherein the substrate  
includes a substrate face, wherein the lower electrode is on the substrate face and  
wherein the first current flow path extends at least partially along a direction that is  
10 nonparallel to the substrate face.

19. A chemical sensor according to Claim 16 wherein the substrate  
includes a substrate face, wherein the lower electrode is on the substrate face and  
wherein the first current flow path extends at least partially along a direction that is  
15 orthogonal to the substrate face.

20. A chemical sensor according to Claim 16 wherein the patterned upper  
electrode includes a plurality of spaced apart fingers, the patterned dielectric layer and  
the patterned upper electrode being patterned to establish the first current flow path  
20 between the lower electrode and the patterned upper electrode through the chemical,  
if present, and the second current flow path between adjacent fingers of the patterned  
upper electrode through the chemical, if present, upon application of voltage between  
adjacent fingers of the patterned upper electrode and between the fingers of the  
patterned upper electrode and the lower electrode.

21. A chemical sensor according to Claim 16 wherein the lower electrode  
25 is a patterned lower electrode.

22. A chemical sensor according to Claim 21 wherein the patterned lower  
30 electrode is patterned to establish a third current flow path between portions of the  
patterned lower electrode through the chemical, if present, upon application of voltage  
between the portions of the flexible lower electrode.

23. A chemical sensor according to Claim 21 wherein the patterned upper electrode and the patterned lower electrode both include a plurality of spaced apart fingers, the patterned dielectric layer, the patterned lower electrode and the patterned upper electrode being patterned to establish the first current flow path between the  
5 patterned lower electrode and the patterned upper electrode through the chemical, if present, the second current flow path between adjacent fingers of the patterned upper electrode through the chemical, if present, and a third current flow path between adjacent fingers of the patterned lower electrode through the chemical, if present, upon application of voltage between the adjacent fingers of the patterned lower  
10 electrode, between adjacent fingers of the patterned upper electrode and between adjacent fingers of the patterned upper and lower electrodes.

24. A chemical sensor that senses a chemical, comprising:  
a substrate;  
15 a lower electrode on the substrate;  
an upper electrode on the lower electrode opposite the substrate and spaced apart from the lower electrode; and  
means for establishing a first current flow path between the lower electrode  
and the upper electrode through the chemical, if present, upon application of voltage  
20 between the lower electrode and the upper electrode and for establishing a second current flow path between portions of the patterned upper electrode through the chemical, if present, upon application of voltage between the portions of the upper electrode.

25. A chemical sensor according to Claim 24 wherein the substrate includes a substrate face, wherein the lower electrode is on the substrate face and wherein the first current flow path extends at least partially along a direction that is nonparallel to the substrate face.

30 26. A chemical sensor according to Claim 24 wherein the substrate includes a substrate face, wherein the lower electrode is on the substrate face and wherein the first current flow path extends at least partially along a direction that is orthogonal to the substrate face.

27. A chemical sensor according to Claim 24 wherein the means for establishing further comprises means for establishing a third current flow path between portions of the lower electrode through the chemical, if present, upon application of voltage between the portions of the lower electrode.

28. A method of fabricating a chemical sensor that senses a chemical, comprising:

forming a flexible lower electrode on a flexible substrate;

forming a flexible dielectric layer on the flexible lower electrode opposite the flexible substrate;

forming a patterned flexible upper electrode on the flexible dielectric layer opposite the flexible lower electrode; and

patterning the flexible dielectric layer using the patterned flexible upper electrode as a mask to establish a current flow path between the flexible lower electrode and the patterned flexible upper electrode through the chemical, if present, upon application of voltage between the flexible lower electrode and the patterned flexible upper electrode.

29. A method according to Claim 28 wherein the forming a patterned flexible upper electrode comprises forming a patterned flexible upper electrode that includes a plurality of spaced apart fingers that are spaced apart from one another by at least an order of magnitude more than the thickness of the flexible dielectric layer.

30. A method according to Claim 28 wherein the flexible substrate comprises polyimide.

31. A method according to Claim 28 wherein the flexible dielectric layer comprises polyimide, a Plasma Enhanced Chemical Vapor Deposition (PECVD) coating and/or a Diamond-Like Carbon (DLC) coating.

32. A method according to Claim 28 wherein the flexible lower electrode and the patterned flexible upper electrode each comprises gold, platinum, palladium and/or copper.

33. A method according to Claim 28 wherein the forming a flexible lower electrode comprises forming a patterned flexible lower electrode on a flexible substrate.

5 34. A method according to Claim 28 wherein the following is performed between the forming a flexible lower electrode and the forming a flexible dielectric layer:

laminating a flexible photoresist layer onto the flexible lower electrode;  
selectively exposing and developing the flexible photoresist layer; and

10 patterning the flexible lower electrode using the flexible photoresist layer that has been exposed and developed as a mask; and

removing the flexible photoresist layer that has been exposed and developed from the flexible lower electrode layer that has been patterned.

15 35. A method according to Claim 28 wherein the forming a patterned flexible upper electrode comprises:

forming a flexible upper electrode layer on the flexible dielectric layer;  
laminating a flexible photoresist layer onto the flexible upper electrode layer;  
selectively exposing and developing the flexible photoresist layer; and

20 patterning the flexible upper electrode layer using the flexible photoresist layer that has been exposed and developed as a mask; and

removing the flexible photoresist layer that has been exposed and developed from the flexible upper electrode layer that has been patterned.

25 36. A method according to Claim 28 wherein the patterning the flexible dielectric layer comprises reactive ion etching the flexible dielectric layer using the patterned flexible upper electrode as a mask.

30 37. A method of fabricating a plurality of chemical sensors that sense a chemical, comprising:

forming a series of laterally spaced apart flexible lower electrodes on a flexible substrate;

forming a flexible dielectric layer on the series of laterally spaced apart flexible lower electrodes opposite the flexible substrate;

forming a series of patterned flexible upper electrodes on the dielectric layer, a respective one of which is opposite a respective one of the series of flexible lower electrodes; and

5 patterning the flexible dielectric layer using the series of patterned flexible upper electrodes as a mask to establish a current flow path between a respective flexible lower electrode and a respective patterned flexible upper electrode through the chemical, if present, upon application of voltage between the flexible lower electrode and the patterned flexible upper electrode.

10 38. A method according to Claim 37 wherein the forming a series of patterned flexible upper electrodes comprises forming a series of patterned flexible upper electrodes that each includes a plurality of spaced apart fingers that are spaced apart from one another by at least an order of magnitude more than the thickness of the flexible dielectric layer.

15 39. A method according to Claim 37 wherein the flexible substrate comprises polyimide.

20 40. A method according to Claim 37 wherein the flexible dielectric layer comprises polyimide, a Plasma Enhanced Chemical Vapor Deposition (PECVD) coating and/or a Diamond-Like Carbon (DLC) coating.

25 41. A method according to Claim 37 wherein the flexible lower electrode and the patterned flexible upper electrode each comprises gold, platinum, palladium and/or copper.

42. A method according to Claim 37 wherein the forming a series of laterally spaced apart flexible lower electrodes comprises:  
forming a flexible lower electrode layer on the flexible substrate;  
30 laminating a flexible photoresist layer onto the flexible lower electrode layer; selectively exposing and developing the flexible photoresist layer; patterning the flexible lower electrode layer using the flexible photoresist layer that has been exposed and developed as a mask; and



removing the flexible photoresist layer that has been exposed and developed from the flexible lower electrode layer that has been patterned.

43. A method according to Claim 37 wherein the forming a series of  
5 patterned flexible upper electrodes on the dielectric layer comprises:  
forming a flexible upper electrode layer on the flexible dielectric layer;  
laminating a flexible photoresist layer onto the flexible upper electrode layer;  
selectively exposing and developing the flexible photoresist layer;  
patterning the flexible upper electrode layer using the flexible photoresist layer  
10 that has been exposed and developed as a mask; and  
removing the flexible photoresist layer that has been exposed and developed from the flexible upper electrode layer that has been patterned.

44. A method according to Claim 37 wherein the patterning the flexible  
15 dielectric layer comprises reactive ion etching the flexible dielectric layer using the series of patterned flexible upper electrodes as a mask.

45. A method of sensing a chemical using a chemical sensor that includes a substrate, a patterned lower electrode on the substrate, a patterned dielectric layer on  
20 the lower electrode opposite the substrate and a patterned upper electrode on the patterned dielectric layer opposite the lower electrode, the method comprising:  
applying voltage between adjacent portions of the patterned upper electrode, between adjacent portions of the patterned lower electrode and between adjacent portions of the patterned upper and lower electrodes, while the chemical sensor is  
25 potentially exposed to the chemical.

46. A method according to Claim 45 wherein the patterned upper electrode and the patterned lower electrode both include a plurality of spaced apart fingers, and wherein the applying comprises:  
30 applying voltage between adjacent spaced apart fingers of the patterned upper electrode, between adjacent spaced apart fingers of the patterned lower electrode and between adjacent fingers of the patterned upper and lower electrodes, while the chemical sensor is potentially exposed to the chemical.